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DEVELOPMENT OF A COMPUTER PROGRAM FOR USE IN THE ANALYSIS OF FUTURE LAND, BUILDING, AND STAFF REQUIREMENTS IN INSTITUTIONS OF HIGHER LEARNING. FINAL REPORT.

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THIS PAPER IS A REPORT ON A RESEARCH PROJECT UNDERTAKEN TO DEVELOP A COMPUTER PROGRAM WHICH WOULD PROVIDE PERIOD-BY-PERIOD ESTIMATES OF FUTURE LAND, BUILDING, AND STAFF REQUIREMENTS UNDER VARIOUS ASSUMPTIONS ABOUT THE CHARACTER OF THE STUDENT BODY, EDUCATIONAL POLICIES, LEVEL OF RESEARCH ACTIVITY, LEVEL OF SERVICE TO THE COMMUNITY, AND CHARACTER OF BUILDINGS. THE COMPUTER PROGRAM WAS DESIGNED TO HANDLE PROJECTION OF VARIABLES WHICH AFFECT STAFF AND FACILITIES REQUIREMENTS AND PRODUCE ESTIMATES OF REQUIREMENTS AT ANY PROJECTED TIME IN THE FUTURE. THREE MAJOR ACTIVITIES UNDERTAKEN DURING THE PROJECT INCLUDED--(1) CODING AN EXPERIMENTAL COMPUTER PROGRAM, (2) CODING THE MAIN COMPUTER PROGRAM, AND (3) ASSEMBLING INPUT DATA FOR THE PROGRAM. THE GOAL OF WRITING A COMPLETE AND FINISHED COMPUTER PROGRAM WAS NOT ACHIEVED AT THE TIME THIS REPORT WAS WRITTEN. (HW)

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September 1967

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Robert C. Meier

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University of Washington
Seattle, Washington

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INTRODUCTION

An essential ingredient for effective management of any organization is the development and utilization of methods for evaluating the impact of present and future conditions and programs on the staff and facilities requirements of the organization. In institutions of higher learning this involves investigating the effects of projected student population sizes and characteristics and projected research activities on the staffs, facilities, and services which must be provided. One of the urgent requirements to further such planning efforts is an ability to efficiently analyze current conditions and rapidly compute future staff and facility requirements from estimates of the character of future educational programs and student body characteristics.

The primary objective of this project was to develop a computer program to provide period by period estimates of future land, building, and staff requirements under various assumptions as to: character of student body, educational policies, level of research activity, level of service to the community, character of buildings, and so forth. The computer program was designed to be capable of taking projections of variables which affect staff and facilities requirements and produce estimates of requirements at any projected time in the future. This would then provide the opportunity to observe the effects of different projections of external variables and also provide an opportunity to manipulate those variables which can be controlled to see how requirements are altered.

Some of the variables and relationships which are relevant to this planning process are shown in the diagram in Appendix A. This diagram shows the relationships thought to be particularly applicable to the University of Washington. However, the computer program was designed to be sufficiently general and flexible to be useful with some modification at other institutions of higher learning.

In the last several years, attempts have been made at institutions such as the University of Nebraska, Duke University, Michigan State University, and the University of Rochester to develop related computerized planning models. At the present time, work of this nature is in its infancy, and there is no consistent pattern which has emerged. The programming approach which has been used in this research, consequently, is not similar to any other work which has been done in the area.

METHOD

Development of an integrated planning tool as described in the preceding section involves two quite different processes:

a) The conceptualization and coding of computer programs.

b) The provision of current data, ratios, standards, projections, and so forth to be used as input to the computer program.

Neither of these processes is amenable to description in terms of a straight-forward methodological procedure, such as a particular data gathering technique or a particular form of statistical analysis.

The methodology of the project is best described in terms of the three major activities undertaken during the project:

a) Coding of an experimental computer program. This preliminary work was undertaken prior to the start of the portion of the research project financed by the Office of Education and Esso Education Foundation grants. A small FORTRAN program was written to demonstrate the feasibility on a small scale of the type of calculations needed to analyze quantitatively relationships shown in the diagram in Appendix A. This program was run on the IBM 7094 at the University of Washington. The exploratory work also demonstrated that the problems were essentially ones of handling and summarizing large amounts of data on which only elementary mathematical operations are performed.

b) Coding of the main computer program. Because the experimental computer work determined that the problem was essentially one of data manipulation, COBOL was selected as the language for the main computer program. It was also decided to develop a higher level pre-compiler written in COBOL which would create some of the COBOL programs necessary to do the actual data manipulations. The higher level pre-compiler was intended to make it feasible to change the final program easily and avoid being committed to only one particular model as expressed by the final program. The COBOL programs were written for the Burroughs 5500 at the University of Washington with provisions for running some of the programs remotely from a terminal located at a distance from the computer.

c) Assembly of input data for the programs. The work on this phase of the research project consisted of ascertaining the form and condition of master records from the University of Washington, defining units to be used in the data manipulations, and screening published materials for information on standards, ratios, etc. developed at other schools or in other research projects.

RESULTS

In the developmental stages a large computer program is usually a series of smaller programs which are written and debugged separately. These sub-programs are then put together into the final complete program. This research project has resulted in the development or partial development of separate computer programs to accomplish the following functions:

a) Cleaning of master records to be used as input to the program.

b) Creation and maintenance in the computer memory of data banks to be used as sources of data for projections, simulations, etc.

c) Generation of reports both in tabular and narrative form from information in the data banks and from information resulting from manipulations of the data banks.

d) Interrogation of information in the data banks from a remote terminal.

e) Graphic display of information in the data banks and of the results of any computations by the program. (See example in Appendix B)

These programs have not as yet been linked together into a final complete program which has the capability to do the type of analyses discussed in the introduction section of this report. (Further discussion of the capabilities of the individual programs and the stage of development of each appears in Appendix C.)

Assembly of the actual input data for the computer program was not a main objective of the research project. However, sufficient investigation was done to ensure that data will be available when the complete program becomes operational.

DISCUSSION

The objective of this research project was to write a complete and finished computer program to be used as a long-range planning tool. This goal has not been achieved as yet in spite of the considerable amount of time and effort devoted to the project. The reasons for falling short of the intended goal are both external and internal to the project itself. We will discuss the major external and internal problems in that order.

A major problem throughout the project was with the Burroughs 5500 computer. The machine was installed shortly before the project began and, like all newly installed computers, numerous operating problems, principally with the software, were encountered. Neither the operating system of the machine nor the COBOL compiler were reliable or lived up to expectations. These problems were further magnified by the unfamiliarity of both the personnel at the computer center and the project programmers with the machine and its operating systems. Some of the initial problems have gradually been eliminated, but certain supposed capabilities such as the permanent storage of files of information in the machine and access to the machine through remote terminals have not been forthcoming.

Scattering the programming effort over many separate parts of the program and attempting to build too much generality and flexibility into the program were the principal contributing internal factors which slowed down development of a complete program. As shown in Appendix C, many interesting and useful programs have been written and some very interesting programming concepts developed, but these do not separately constitute the final program as envisioned at the beginning of the project. Although the problems with the computer itself would probably have prevented completion of the final program during the time allotted for the project regardless of how the programming was directed, narrowing of the scope of programming activities would have resulted in more progress toward a finished program than was actually made.

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The basic objective of the research project, that of writing a computer program useful in long-range planning activities for a university, is a sound objective in spite of the fact it has not as yet been attained. Nothing that was encountered during the course of the project suggests that there is any significant theoretical problem in writing the desired program, but the magnitude of the task was substantially underestimated. This experience suggests that estimates of how long it takes to develop computer programs should be extremely conservative even when the programs involve only relatively unsophisticated computations. Also, programmers should be rather narrowly constrained in their approach to the programming task. There appears to be a tendency for programmers to work on too many aspects of a large program at once and to attempt to be unduly sophisticated, losing sight of the fact that the educational administrator must, of necessity, be interested in getting useful output as quickly as possible.

The experience with the shortcomings of the Burroughs 5500 computer system and its software points out a significant acute problem in the computing field. Computer manufacturers have made great technological advances in recent years so that complex data processing systems, such as the one which was to be developed in the course of this project, are technologically quite feasible. Unfortunately, there are often inadequacies in the software, shortages of trained people to operate the equipment and assist users in working out problems, and insufficient support by the manufacturer so that computer systems that are <u>feasible</u> are not easily brought to a state of <u>practical</u> usefulness. Some alleviation of this problem might be obtained if educational instituions when negotiating for the purchase or lease of a computer, clearly specified the capabilities that the machine should have and insisted on the payment of severe penalties if the machine failed for any reason to provide these capabilities.

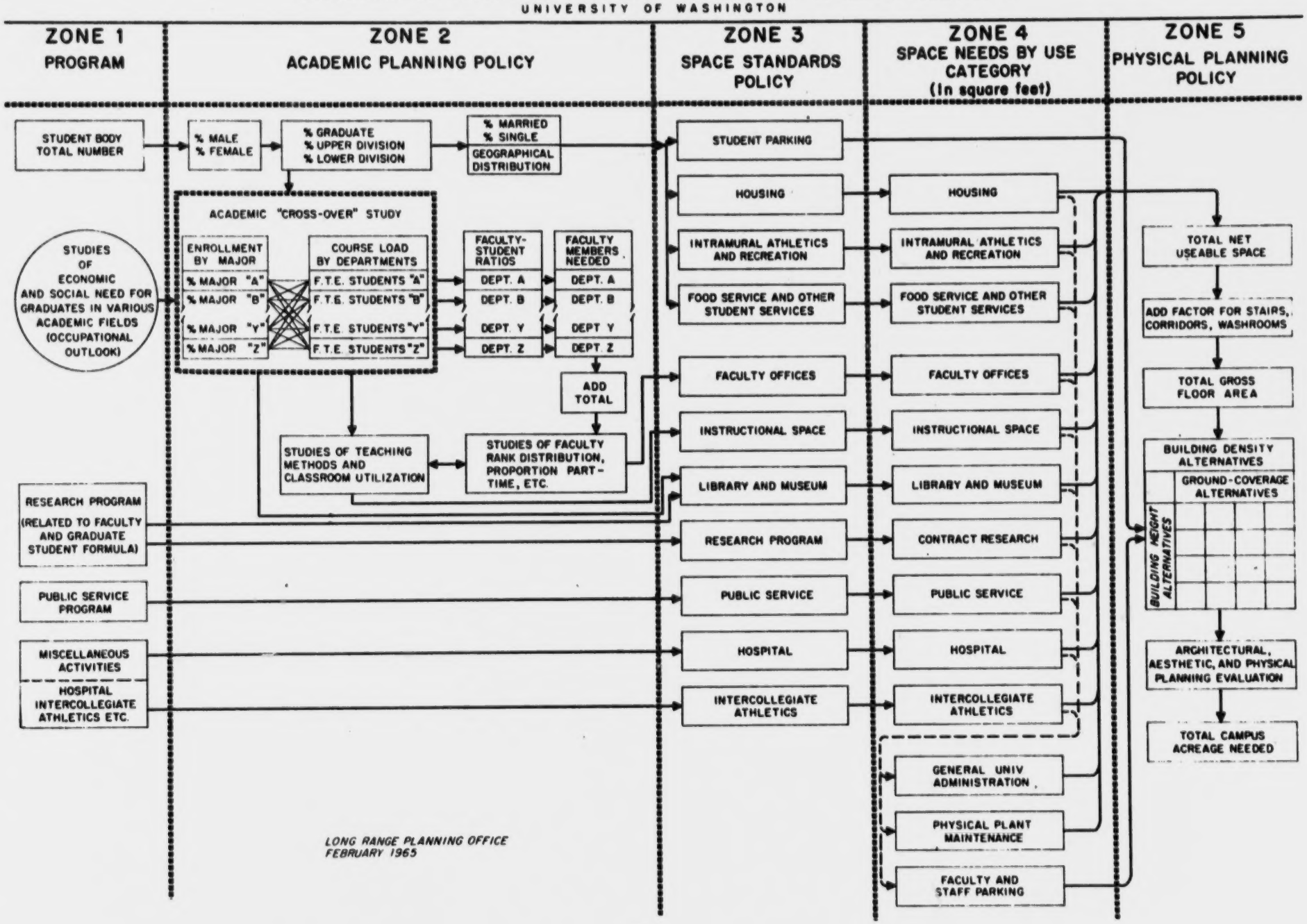
SUMMARY

This research project involved the writing of computer programs designed to facilitate making projections of future land, building, and staff requirements in institutions of higher learning. The project has resulted in the determination of a basic programming philosophy for doing the necessary calculations and analyses, and portions of the actual programs have been written. While the goal of a complete program was not attained, all necessary concepts have been explored and further programming effort should result in a finished program which would be useful as a management planning tool.

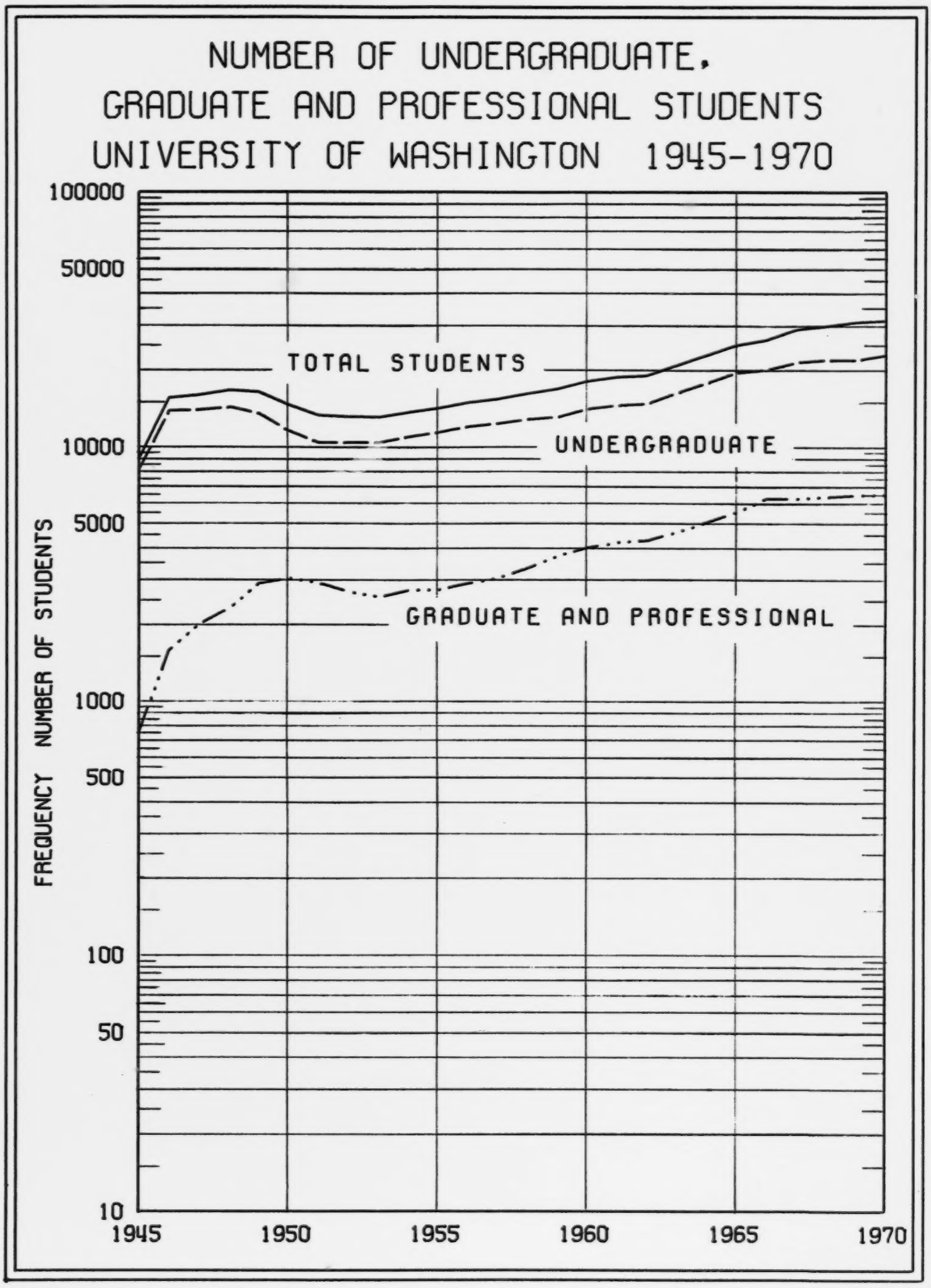
APPENDIX A

DIAGRAM OF STUDENT / SPACE / DENSITY RELATIONSHIPS

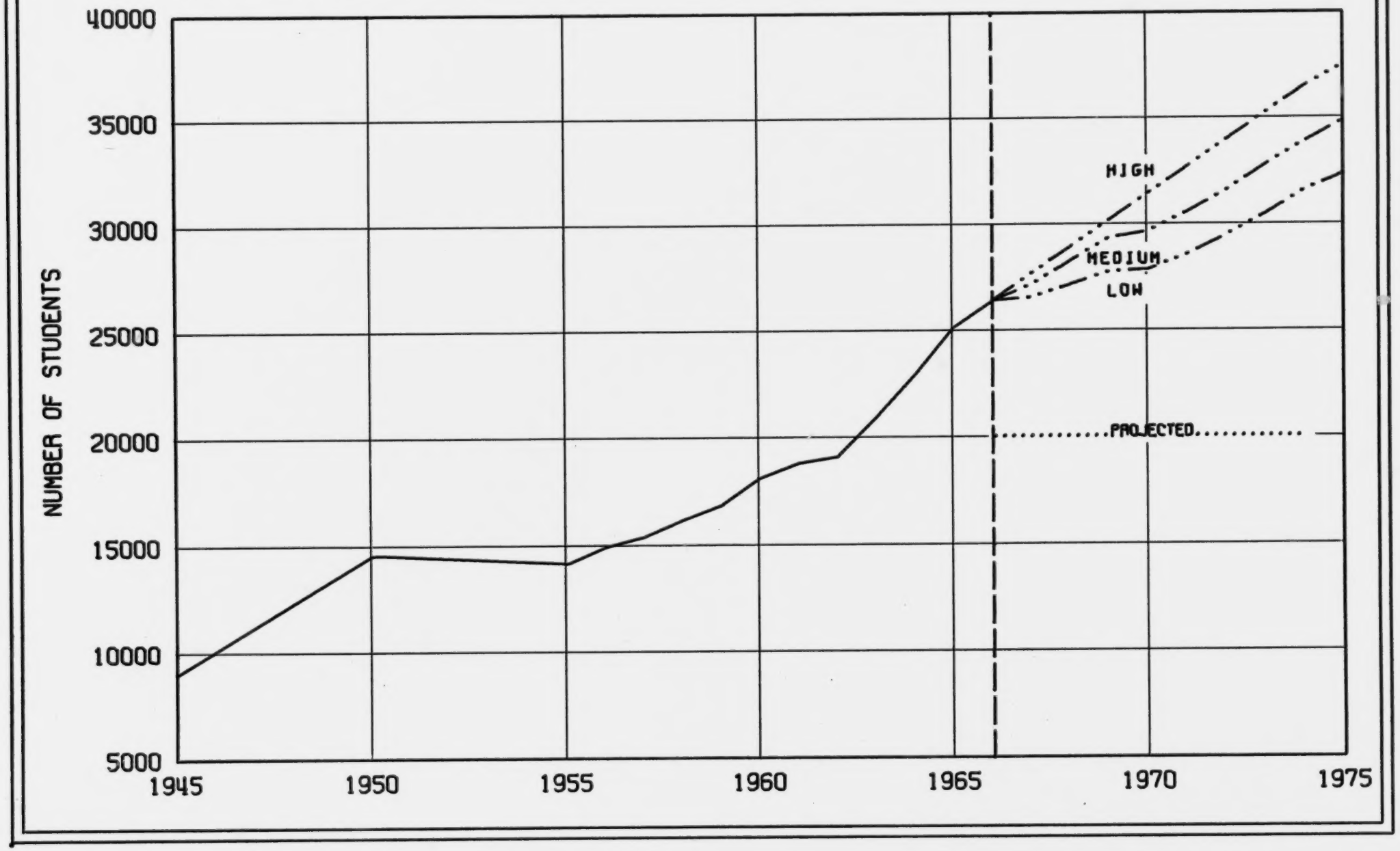
UNIVERSITY OF WASHINGTON



LONG RANGE PLANNING OFFICE
FEBRUARY 1965


NUMBER OF UNDERGRADUATE,
GRADUATE AND PROFESSIONAL STUDENTS
UNIVERSITY OF WASHINGTON 1945-1970
FREQUENCY NUMBER OF STUDENTS
100000
50000
10000
5000
1000
500
100
50
10
TOTAL STUDENTS
UNDERGRADUATE
GRADUATE AND PROFESSIONAL
1945
1950
1955
1960
1965
1970

ENROLLMENT TRENDS AND FORECASTS
UNIVERSITY OF WASHINGTON 1945 TO 1975



APPENDIX C

Description and Status of Computer Programs Developed During Research Project

Cleaning program for student master file (100% complete) The student master file tape which is one of the necessary inputs to the program was found to have certain deficiencies. The cleaning program corrects these deficiencies making it suitable as a basic source of data for further computations. A separate program must be written for each master file from which information is to be drawn.

File creation program (50% complete) The basis of the entire planning and simulation process is a data bank of cross-classified and summarized data drawn from such source records as student master file, space inventory records, etc. The file creation program is a pre-compiler which produces COBOL programs which, in turn, set up the appropriate data files in the computer. Instead of writing a COBOL program to define each type of data file desired and the source record from which it comes, the file creation program permits the user to define according to a set of simple rules the form of the file to be established and the source of information for the file. The file creation program, in turn, produces the required COBOL program itself, thereby relieving the user of the large task of programming the form of each file individually in COBOL.

Report generator (50% complete) Like the preceding program, the report generator is a pre-compiler which produces COBOL programs. The user specifies the form of the output desired, and the report generator supplies a COBOL program which will produce the report. Since analyses of future requirements for planning purposes require extensive tabulations in varied format, the report generator permits rapid output of data in a form suitable for analysis without resorting to writing a COBOL program manually in each case. The report generator provides for narrative as well as tabulated formats.

Remote terminal inquiry program (25% complete) The program is designed to permit retrieval of information from the data files in the computer from a remote terminal. The remote terminal access system in conjunction with COBOL is not currently operational on the Burroughs 5500; therefore, this program is not well developed.

Graphic display programs (100% complete) Since summaries of information and projections for planning purposes are often best understood through graphic displays, a set of programs for the CalComp plotter was prepared which simplify the preparation of instructions for graphic output. These programs are capable of producing line graphs, semi-log graphs, column charts, bar charts, population pyramids, and three dimensional graphs with only simple commands.